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PTO/SB/05 (4/98)  
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# UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No. \_\_\_\_\_

First Inventor or Application Identifier: \_\_\_\_\_

Title: Remote Monitoring of Critical Parameters for Calibration

Express Mail Label No. of Manufacturing Equipment and Facilities

## APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1.  \* Fee Transmittal Form (e.g., PTO/SB/17)  
(Submit an original and a duplicate for fee processing)
2.  Specification [Total Pages ]
  - Descriptive title of the Invention
  - Cross References to Related Applications
  - Statement Regarding Fed sponsored R & D
  - Reference to Microfiche Appendix
  - Background of the Invention
  - Brief Summary of the Invention
  - Brief Description of the Drawings (if filed)
  - Detailed Description
  - Claim(s)
  - Abstract of the Disclosure
3.  Drawing(s) (35 U.S.C. 113) [Total Sheets ]
4. Oath or Declaration [Total Pages ]
  - a.  Newly executed (original or copy)
  - b.  Copy from a prior application (37 C.F.R. § 1.63(d))  
(for continuation/divisional with Box 16 completed)
    - i.  **DELETION OF INVENTOR(S)**  
Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

**\*NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.26).**

16. If a **CONTINUING APPLICATION**, check appropriate box, and supply the requisite information below and in a preliminary amendment:

Continuation  Divisional  Continuation-in-part (CIP) of prior application No: \_\_\_\_\_

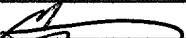
Prior application information: Examiner \_\_\_\_\_

Group / Art Unit: \_\_\_\_\_

For **CONTINUATION or DIVISIONAL APPS** only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

## 17. CORRESPONDENCE ADDRESS

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Name	24117		
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**STATEMENT CLAIMING SMALL ENTITY STATUS  
(37 CFR 1.9(f) & 1.27(b))--INDEPENDENT INVENTOR**

Docket Number (Optional)

Applicant, Patentee, or Identifier: Eric Paton

Application or Patent No.: \_\_\_\_\_

Filed or Issued: \_\_\_\_\_

Title: Remote Monitoring of Critical Parameters for Calibration of  
Manufacturing Equipment and Facilities

As a below named inventor, I hereby state that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees to the Patent and Trademark Office described in:

the specification filed herewith with title as listed above.

the application identified above.

the patent identified above.

I have not assigned, granted, conveyed, or licensed, and am under no obligation under contract or law to assign, grant, convey, or license, any rights in the invention to any person who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern, or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

No such person, concern, or organization exists.

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Separate statements are required from each named person, concern, or organization having rights to the invention stating their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

ERIC PATON  
NAME OF INVENTOR  


Signature of inventor

3/13/00

Date

NAME OF INVENTOR

Signature of inventor

Date

NAME OF INVENTOR

Signature of inventor

Date

## Receipt for documents mailed to the PTO

Enclosed in this Utility Patent Application are the following items. Please review each item and initial it to confirm receipt.

- Application number: Not known
- Filing date of the application : Not known
- Title of the invention

### REMOTE MONITORING OF CRITICAL PARAMETERS FOR CALIBRATION OF MANUFACTURING EQUIPMENT AND FACILITIES

jc825 U.S. PRO  
09/680286  
10/06/00



•	Name of the inventor: Eric Paton		
•	the title and number of pages of each PTO forms enclosed	# of pages	Received?
•	Title	1	_____
•	Utility Patent Application Transmittal	1	_____
•	Statement Claiming Small Entity Status---Independent Inventor	1	_____
•	Declaration for Utility Patent Application (37 CFR 1.63)	1	_____
•	DECLARATION: Utility Patent Application	1	_____
•	Patent Application Fee Determination Record	1	_____
•	the number of pages of specification (excluding claims)	9.5 pages	_____
•	the number of claims and the number of claims pages	17 claims, 2.5 pages	_____
•	the number of figures of drawing and the number of sheets of drawing	4 Figs, 4 pages	_____
•	Declaration statement is included		_____
•	the type and number of other documents that are included		_____
•	the amount of payment and the method of payment	\$345 personal check	_____

REMOTE MONITORING OF CRITICAL PARAMETERS FOR  
CALIBRATION OF MANUFACTURING EQUIPMENT AND FACILITIES

By

Eric N. Paton

CROSS REFERENCES TO RELATED APPLICATIONS

U.S. PATENT DOCUMENTS

5,660,472	08/1997	Peuse et al. ....	359,302
5,967,661	10/1999	Renken et al. ....	08/867,103

## TECHNICAL FIELD

The present invention relates to a device and method of remotely monitoring critical parameters for  
5 calibration of manufacturing equipment and facilities. The present invention has particular applicability in  
remotely monitoring and recording critical parameters wherein the use of wires between the measuring  
device, and the recording device, are difficult or near impossible.

## BACKGROUND ART

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Quantitative parameters in an environment such as temperature, humidity, pH, viscosity, velocity, density, distance, acceleration, liquid and gas flow, chemical composition, gas analysis, electrolyte analysis, vibration frequency, strain, pressure, radiation, and particle counts are a few of the critical gauges in characterizing any environment. These parameters influence dynamic and static mechanical, physical,  
15 electrical, chemical, and diffusive properties of the environment.

Occasionally, these parameters must be monitored or calibrated to authenticate the stability or state of the environment. In particular, this disclosure addresses the environment used for various industries such as farming, mining, construction, non-electrical machinery, transportation equipment (including automobiles), food products, chemicals (including petrochemicals), electrical and electronic  
20 equipment, textiles, utilities, and the natural environment in which we live.

### Applications to Process Control and Monitoring with Factory Automation

Industrial technology has increasingly become capital intensive, and has displaced both skilled and unskilled workers. The term automation, coined from the words automatic and operation, describes all  
25 such processes in which mechanical and/or electronic devices are employed to carry out tasks without human intervention.

Currently, and into the future, manufacturing assembly lines will involve less human intervention through the use of factory automation and robotics. One example of an industry that has incorporated a

high level of factory automation is integrated circuits (IC), flat panel displays, microelectromechanical devices (MEMs) and other electrical materials. Other industries with an increasing focus on automation include farming, mining, construction, non-electrical machinery, transportation equipment (including automobiles), food products, chemicals, electrical and electronic equipment, and clothing.

5        The demands on manufacturing continue to increase, in order to foster continuous improvements in efficiency, throughput, cost reduction, performance, and stability. This allows companies to maintain profitability in a highly competitive market.

Manufacturing process stability requires stable equipment. The objective is for every tool to perform like every other such tool, with no unique signatures. An appropriate combination of well 10 engineered tools and appropriate metrology is necessary to maximize productivity while maintaining acceptable cost of ownership.

To minimize this variation, state-of-the-art manufacturing equipment come installed with permanently attached electronic sensors. These sensors are positioned in close proximity to the area of interest, and linked to computers that monitor any variation in the data, and are triggered by alarms if 15 established tolerances are exceeded.

Similar to other quantitative measuring devices, this data is not accurate unless the sensor is calibrated to a known standard. Otherwise, the measurement can not be universally compared with other sensors measuring the same parameter. To calibrate the permanently installed sensors, another temporary sensor, that measures the same parameter, is routinely used. This temporary sensor may either be 20 previously calibrated to National Institute of Standards and Technology (N.I.S.T.) to provide absolute measurement values, or it is an "internal" standard, to baseline the parameter against other systems in the same manufacturing facility, corporation, or institution.

#### Measurement parameters of interest

25        Quantitative parameters in an environment such as temperature, humidity, pH, viscosity, velocity, density, distance, acceleration, liquid, plasma, and solids analysis, vibration frequency, stress/strain, pressure, radiation, and particle counts are a few of the critical gauges in characterizing any environment.

#### Temperature

One of the most important and commonly measured parameters is temperature. The word "capital goods" will be used in this context to address the manufactured solid, liquid, or gas of interest. Capital goods temperature, is a very influential parameter in controlling the physical properties, and reaction kinetics during process manufacturing. As such, control of temperature and uniformity of 5 temperature, is a key parameter for achieving process control. Common techniques include sensors such as thermocouples, platinum resistors and silicon diodes, which are immersed in the environment of the capital goods.

Other methods of temperature measurement included radiation thermometry or pyrometry. Radiation pyrometry involves measuring long wavelength radiation from an object and making a 10 temperature determination on the basis of that measurement. Radiation pyrometry has several disadvantages. Among these disadvantages is the reliance on a surface optical emissive properties which vary with temperature, and surface /subsurface physical properties. Another non-contact method for measuring surface temperature is with a fluoptic sensor. This technique uses a laser probe, which records the temperature dependent decay rate of a phosphor coating on the capital goods surface.

15 Flow rate

Common methods for measuring flow rate include "paddle wheel" and hinged vane type transducers. For lower flow rate and when size and weight limitations are considered, higher accuracy can be obtained using thermally based anemometers and liquid flow meters. This technique measures the differential temperature between two sensors, or alternatively, measures the energy required to maintain a 20 heated resistance wire at constant temperature.

Distance

Common methods for measuring distance include ultrasonics, radar, and linear variable differential transformers.

Particles

25 Many of our modern, high technology industrial practices demand cleanliness. Specifically, they demand an absence of particle contamination. For example, microelectronic and micromechanical devices demand cleanliness since particles as small as 50nm may cause a degradation in the product yield. Another example may be drawn from the pharmaceutical industry: A parenteral (injectible) drug must be free of

particles that could block a blood vessel, causing a stroke (interruption of blood supply to part of the brain) or necrosis (interruption of blood supply to a tissue). The drug maker, as well as the microelectronic/micromechanical maker, has to manage the production environment to eliminate particle contamination.

5        The basic methods of particle detection employ HeNe lasers, laser diodes, photodiodes, and support equipment. Particles are introduced through inlet jets when monitoring aerosol or gas media, or through capillaries when monitoring liquid media. Laser power illuminates the particles in the sample cavity. The particles produce a pulse of light that is detected by a photodiode. The photodiode converts the pulse to an electrical signal (converts current to voltage), amplifies the voltage, and compares the pulse 10 voltage to a set of thresholds. If a particle exceeds one threshold but not the next greater threshold, the instrument places the particle into the lower threshold. The threshold value corresponds to the size of the particles, and the frequency of scattering events corresponds to the quantity of particles in the sample volume.

15        Humidity

Relative humidity is a difficult physical parameter to transduce, and most transducers available require complex signal conditioning circuitry. Common methods include measuring the change in resistance or capacitance of a sensor in contact with the environment.

Pressure

20        Common methods for measuring pressure include: a) barometers (capacitive, bonded strain gauge and semiconductor transducers), b) manometers (difference in height  $h$  of two mercury columns, one open to the atmosphere and the other connected to a source of known pressure), c) Bourdon tubes (a tube that straightens out when the internal pressure exceeds the external pressure, d) Aneroid (thin flexible ends of an evacuated chamber that are pushed in or out by an external pressure) and d) ion gauges.

25        Viscosity

The viscosity of a fluid is given a quantitative definition in terms of an experiment in which a plate of area  $A$  is pulled across a layer of fluid  $s$  thick. For most fluids, it is found that the force  $F$  required to pull the plate at a constant speed  $v$ , is proportional to  $A$  and  $v$ , and inversely proportional to  $s$ .

$$N = F * s / A * v$$

### Radiation

Unstable atomic nuclei emit three kinds of radiation:

- Alpha particles
- Beta particles
- Gamma particles

A magnetic field is used to quantify each of these particles. With a magnetic field directed into the page, the positively charged alpha particles are deflected to the left, and the negatively charged beta particles are deflected to the right. Gamma rays carry no charge and are not affected by the magnetic field.

10

### Other More Advanced Chemical/Material Analysis Techniques

Many techniques exist for characterizing liquids, gases, plasmas and solids. These include, but are not limited to:

- electron beam instruments
  - 1. Energy dispersive x-ray spectroscopy (EDS)
  - 2. Cathodoluminescence (CL)
- x-ray/electron diffraction and scattering
- electron/x-ray emission spectroscopy
  - 1. x-ray photoelectron spectroscopy (XPS)
  - 2. Ultraviolet Photoelectron Spectroscopy (UPS)
  - 3. Auger Electron Spectroscopy (AES)
  - 4. Reflection High Energy Electron Diffraction (REELS)
  - 5. X-ray Fluorescence (XRF)
- visible/UV emission, reflection and absorption
  - 1. Photoluminescence (PL)
  - 2. Modulation Spectroscopy
  - 3. Variable Angle Spectroscopic Ellipsometry (VASE)
- Vibrational Spectroscopy
  - 1. Fourier Transform Infrared Spectroscopy (FTIR)
  - 2. Raman Spectroscopy
  - 3. Solid State Nuclear Magnetic Resonance (NMR)
- Ion Scattering
  - 1. Rutherford Backscattering Spectroscopy (RBS)
  - 2. Elastic Recoil Spectroscopy (ERS)

3. Ion Scattering Spectroscopy (ISS)

- Mass/Optical spectroscopy
  - 1. Residual Gas Analyzer (RGA)
  - 2. Dynamic/Static Secondary Ion Mass Spectroscopy
  - 5 3. Laser Ionization Mass Spectroscopy (LIMS)
  - 4. Sputtered Neutral Mass Spectroscopy (SNMS)
  - 5. Glow Discharge Mass Spectroscopy (GDMS)
  - 6. Inductively Coupled Plasma Mass Spectroscopy
  - 7. Inductively Coupled Plasma/Optical Emission Spectroscopy
- 10 • Neutron/Nuclear Spectroscopy
  - 1. Neutron Diffraction
  - 2. Neutron Reflectivity
  - 3. Neutron Activation Analysis (NAA)
  - 4. Nuclear Reaction Analysis (NRA)

15 Details on these measurement techniques can be found in ref. [3, Encyclopedia of Materials Characterization, C. R Brundle, C.A. Evans, S. Wilson, C 1992, Reed Publishing, pp 1-750.]

#### Measurement Accessibility

20 In high volume mass production, capital goods are manufactured rapidly through machines or tools using fully automatic robotic handling. In many instances, the environment within the machine or tool may be inaccessible to place a measurement probe at the point of interest. For example, robotic handling equipment may be used to transfer the capital goods through small openings and air locks, and into a series of vacuum chambers, or into chemical tanks, furnaces, hot plates, plumbing, or light exposure 25 stages. In addition, capital goods are introduced into hostile environments such as extreme temperatures, poisonous gases, low pressure (i.e. vacuum), acid or basic solutions, or radiation.

30 The aforementioned factors inhibit the ability for fast and non-intrusive capital goods measurement. More specifically, the manufacturing equipment may stop regular production for an extended period of time. In many instances, the system must be purged of all inhospitable environments, then dismantled to allow manual placement of the measurement device into the process area of interest. Next, the system must be returned to the standard process conditions before any measurements can be made. After the measurement is complete, the system must be purged again of all inhospitable environments, and the calibration device is removed. Finally, the system is returned to the standard

process conditions before the equipment is returned for normal processing. This extended downtime is costly and laborious.

## SUMMARY OF THE INVENTION

5

An advantage of the present invention is a device that measures any one or more of the parameters such as temperature, liquid and gas flow rate, distance, particles, humidity, pressure, viscosity, radiation, velocity, density, acceleration, stress/strain, pH and more advanced chemical/material analysis techniques as described in the prior art, in such a way that the sensor is free from wires connecting it to the recorder.

10 The present invention has particular applicability in monitoring the aforementioned parameters on capital goods in microelectronic processing. The present invention has the advantage of monitoring these parameters on the capital goods remotely, without the need for wires extending from the capital goods surface.

15 Additional advantages and other features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from the practice of the invention. The objects and advantages of the invention may be realized and obtained as particularly pointed out in the appended claims.

20 According to the present invention, the foregoing and other advantages are achieved in part by a sensor or sensors attached to the surface, subsurface, or surrounding environment of the capital goods and a wire attached from the sensor, to another device attached to the capital goods adjacent to the sensor. This device records the data internal to the device for later downloading, or immediate transmitting of this data to a location remote to the capital goods and measurement device. This measurement device has particular advantage since it resides completely on the capital goods, giving the capital goods freedom from wires that otherwise must be attached to a recording device external to the environment of interest. This added 25 benefit allows for non-intrusive installation of the measurement device via the same robotic or automated handling or transport systems using to move the ordinary capital goods.

Additional advantages of the present invention will become readily apparent to those having ordinary skill in the art from the following detailed description, wherein the embodiments of the present

invention are described, simply by way of illustration of the best mode contemplated for carrying out the present invention. As will be realized, the invention is capable of other and different embodiments, and its several details are capable of modifications in various obvious respects, all without departing from the present invention. Accordingly, the drawings and description are to be regarded as illustrative in nature, 5 and not as restrictive.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The various features and advantages of the present invention will become more apparent as a detailed 10 description of the embodiments thereof is given with reference to the appended figure described below.

Fig. 1 schematically illustrates sensors mounted on capital goods of the prior art.

Fig. 2 schematically illustrates the sensors and device of the present invention.

Fig. 3 is a cross-section view of the present invention.

Fig. 4 schematically illustrates the sensors and device of the present invention.

15

#### DESCRIPTION OF THE INVENTION

The present invention addresses and solves the problem of measuring process parameters on the surface, sub-surface, or surrounding environment of manufactured capital goods used in industries such as 20 farming, mining, construction, non-electrical machinery, transportation equipment (including automobiles), food products, chemicals (including petrochemicals), electrical and electronic equipment, textiles, and utilities. These capital goods are measured without the requirement for external connections away from the capital goods surface or environment, for recording the process data.

In accordance with the present invention, the calibration or measurement device comprises one or 25 more sensors **12**, placed on or near capital goods **16**, connected by wire **10**, to an electronic device **14**. This electronic device comprises one or more analog-to-digital converters. The digital data can be recorded and saved as a function of time, using one of two options:

1) The digital data can be stored as solid state memory, and reside on the capital goods. Later, after the recording is complete when the capital goods and measurement device are accessible, the data can be downloaded and saved on a computer or other storage device **24**.

2) The digital data can be transmitted **26** instantaneously using a wireless transmitting module, and recorded using a wireless receiving module **22** and saved on a computer or other storage device **24**.

Instantaneous monitoring such as that described in Option 2 is preferred since it allows for real-time data collection. In some applications, wireless transmission is not feasible due to impassible boundaries or materials separating the transmitter and receiver. In these instances, Option 1 is necessary, where the data is later downloaded for observation.

In an embodiment of the present invention, when the environmental substance to be measured is temperature, the electronic device **13** must remain isolated from the surrounding heat and/or other hostile environments. To prevent heat transfer to the device **13**, a thermally insulating material **14** resides between the heat source, and the device **13**. In most applications, the only source of heat resides on a heater below the capital goods. For applications in which the heat source resides above, or when the device is immersed in the hostile environment, thermal insulation must be provided on all sides of the device. Materials with low thermal conductivities, yet can withstand high temperatures, include, but are not limited to, vermiculite, silica or carbon aerogels, zirconia, stabilized zirconia, and alumina.

Power is provided to the electronic device **13** by a lightweight, compact, and heat resistant battery **20**. Lithium and lithium ion batteries meet these requirements, providing high temperature storage capacity up to 500 hours at 150C without any significant voltage discharge.

In an embodiment of the present invention, when the environmental substance to be measured is temperature, the result must not be influenced by conduction along the leads and the sensors. Additionally, the electronic device **13** and battery **20** must reside sufficiently away from the sensors, such that the electronics and battery do not act as a heat reservoir. Figure 4 shows an example of how the sensors **10**, electronic device **13**, and battery **20** are positioned to provide maximum separation, and the sensors **10** provide uniformity data across the diameter of the capital goods **16**.

An advantage of the present invention, as stated in the earlier embodiment, is the non-intrusive handling and positioning of the capital goods measuring device, by the same robotics or automated transport used to handle the standard capital goods material for manufacturing. Several physical requirements of the measurement device must be met to allow for the robotics to operate without fault in  
5 the handling. These physical requirements are mass, balance and dimension. For most robotic systems, the added mass of the battery **20**, electronics **13**, and sensors **10** should not exceed three times (3X) the weight of the capital goods by itself. Secondly, position of the electronic device **13**, battery **20**, and sensors **10** must also be mass balanced across the capital goods **16**. Figure 4 provides an example of how the battery  
**20** with mass  $m_b$  counter-balances the electronic device **13** with mass  $m_e$ , where  $m_b = m_e$ . Finally,  
10 dimensional constraints exist such that the capital goods with the measurement device attached, is similar to, or only slightly larger than the standard capital goods dimensions. As the capital goods passes between various environments, a minimum clearance must exist to allow for a large enough safety margin for robotic handling inaccuracies, or for other transfer mechanism space limitations.

What I claim is:

1. An apparatus for measuring critical parameters on equipment used in manufacturing, without evasive interruptions to said equipment.
- 5 2. The critical parameters in claim 1 include temperature, liquid and gas flow rate, distance, particles, humidity, pressure, viscosity, radiation, velocity, density, acceleration, stress/strain, pH and other more advanced chemical/material analysis techniques as described in the prior art.
3. The apparatus in claim 1 comprising capital goods having surface with attached sensors, recording device, and energy source thereon.
- 10 4. The recording device in claim 3 comprising analog to digital converters, signal conditioning devices and a means of saving the data.
5. The apparatus in claim 1 wherein said capital goods, sensors, and recording device are free from wires extending from the surface of said capital goods.
- 15 6. The means of saving the data in claim 4 wherein said data is A: transmitted digitally to an external receiver and computer, or B: stored locally on said capital goods with solid state memory, and later downloaded to said computer.
7. The energy source in claim 3 comprising a battery with efficient storage of charge at elevated temperatures up to 150C. Such batteries exhibit these properties, such as lithium metal, lithium ion, or Nickel Metal Hydride (NiHy)
- 20 8. The remote device residing on the capital goods of interest in claim 5, such that the same robotic, automated handling used to transport or direct the capital goods, is used to transport the said apparatus in claim 1.
- 25 9. The recording device and energy storage media in claim 3, and external hostile environment, with material therebetween with special isolating properties.

10. The isolation material in claim 9, wherein said recording device and said energy storage media is protected from said hostile environment.

11. When said environmental substance to be measured is extreme heat in excess of 100C, the isolation  
5 material in claim 9 is a material with low thermal conductivity, emmisivity, and convectivity.

12. The environment of claim 11, wherein said isolation material is chose from the group consisting of: silica aerogel, carbon aerogel, silica whiskers, vermiculite, stabilized zirconia, clay, and combinations thereof.

10 13. The solid state memory of claim 6, wherein said solid state memory is chosen from the group consisting of: Electrically Erasable Read Only Memory, (EEPROM), Ferroelectric Random Access Memory (FeRAM), Magnetic Bubble Memory, Flash, Dynamic Random Access Memory, Static Random Access Memory, First In / First Out (FIFO) and Giant ManetoResistive Random Access Memory (GMR RAM).

15 14. When said environmental substance to be measured is liquid, especially those of basic or acid solutions, the isolation material in claim 9 is a material with high resistance to chemical attack, and low permeability.

20 15. The apparatus in claim 1 wherein said sensors, energy storage, and recording device are vacuum compatible. Alternatively, if any of the said sensors, energy storage, and recording device are not vacuum compatible, an isolation material in claim 9 is a material that hermetically seals the sensors, energy storage and/or recording device from said vacuum environment.

25 16. The apparatus in claim 1 wherein said sensors, energy storage, and recording device are radiation hard if said environmental substance is radiation of any wavelength that may compromise sensors, energy storage, or electronic recording devices. Alternatively, if any of the said sensors, energy storage, and recording device are not radiation hard, an isolation material in claim 9 is a material that isolates the sensors, energy storage and/or recording device from said radiation environment.

17. The manufacturing in claim 1 include industries such as farming, mining, construction, non-electrical machinery, transportation equipment (including automobiles), food products, chemicals (including petrochemicals), electrical and electronic equipment, textiles, and utilities.

REMOTE MONITORING OF CRITICAL PARAMETERS FOR  
CALIBRATION OF MANUFACTURING EQUIPMENT AND FACILITIES

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ABSTRACT OF THE DISCLOSURE

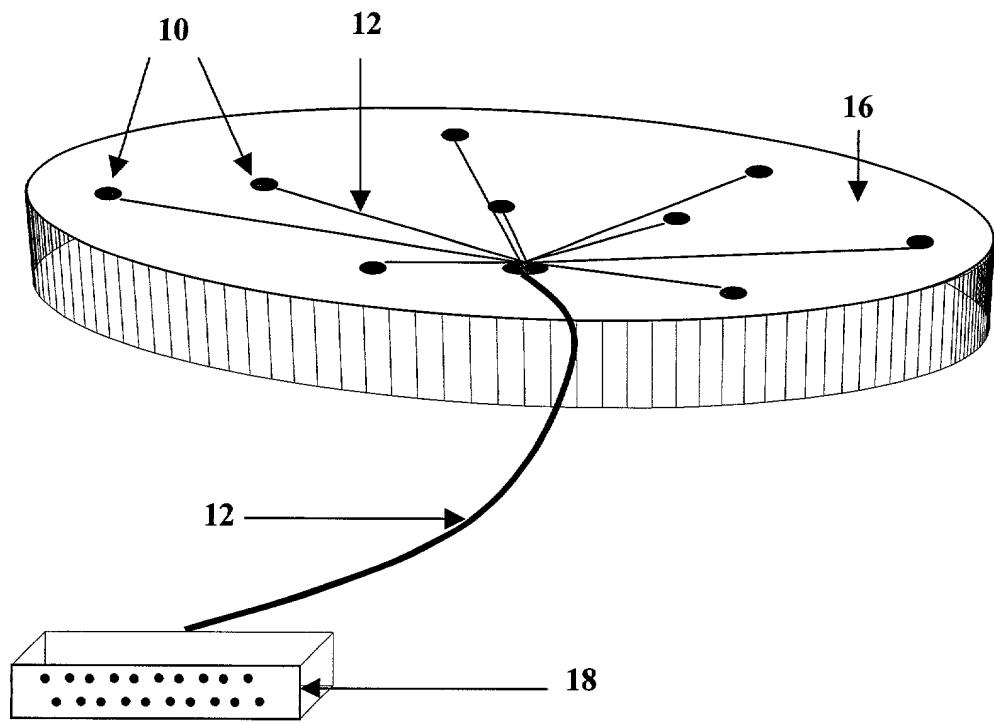
Monitoring of parameters using remote sensors, which are attached directly to the product material, allows for non-intrusive entry into the manufacturing area, via the same robotic handling or automated systems used to transport the standard product material. Data is recorded from the sensors, by 10 wireless transmission, or when a signal is impossible, on-board memory will store the data for later downloading.

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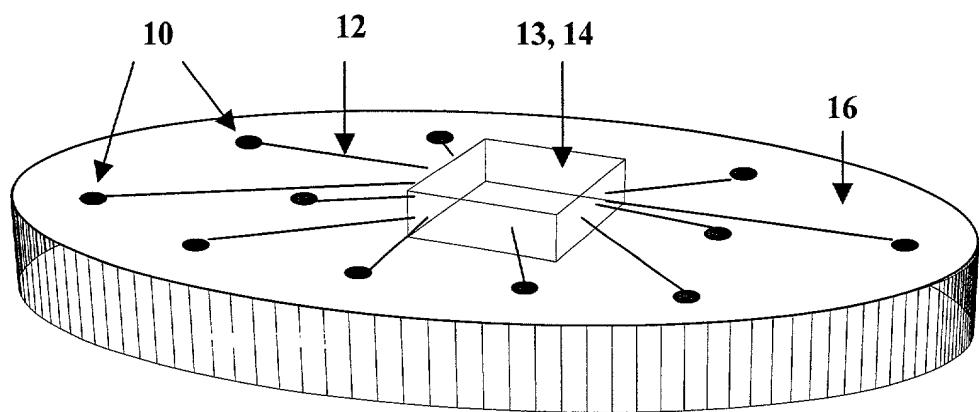
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10

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Fig. 1



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Fig. 2

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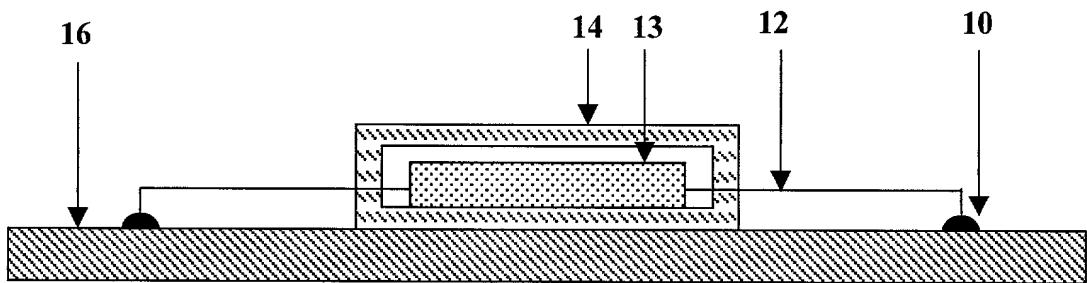


Fig. 3

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17

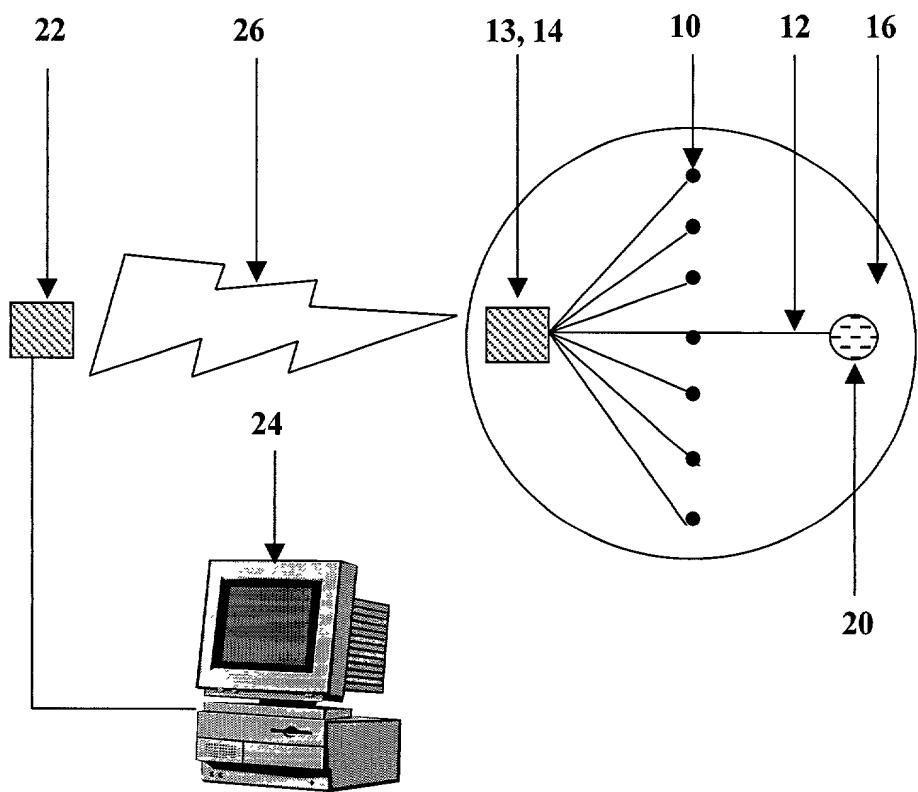


Fig. 4

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PTO/SB/01 (12-97)

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Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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**DECLARATION FOR UTILITY OR  
DESIGN  
PATENT APPLICATION  
(37 CFR 1.63)**

Declaration Submitted with Initial Filing       Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	
First Named Inventor	Eric Paton
COMPLETE IF KNOWN	
Application Number	/
Filing Date	
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

*Remote Monitoring of Critical Parameters for Calibration  
of Manufacturing Equipment and Facilities*

the specification of which

*(Title of the Invention)*

is attached hereto

OR

was filed on (MM/DD/YYYY)  as United States Application Number or PCT International

Application Number  and was amended on (MM/DD/YYYY)  (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	Certified Copy Attached? NO
			<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

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Application Number(s)	Filing Date (MM/DD/YYYY)	
		<input type="checkbox"/> Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

[Page 1 of 2]

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U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact business with the Patent and Trademark Office connected therewith:  Customer Number  → **24117** Place Customer Number or Bar Code Label here

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 Registered practitioner(s) name/registration number listed below

Name	Registration Number	Name	Patent Filing or Registration Number

Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to:  Customer Number **24117** OR  Correspondence address below

Name					
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor:	<input type="checkbox"/> A petition has been filed for this unsigned inventor				
Given Name (first and middle [if any])			Family Name or Surname		
<i>ERIC PATON</i>					
Inventor's Signature	<i>[Signature]</i>				
Date	<i>3/13/00</i>				
Residence: City	498 Rio Grande	State	CA	Country	USA
Citizenship USA					
Post Office Address					
Post Office Address					
City	Morgan Hill	State	CA	ZIP	95037
Country	USA				

Additional inventors are being named on the \_\_\_\_\_ supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto